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Supplementary appendix

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Supplementary appendix

Supplement to: Combining the effects of increased atmospheric carbon dioxide on protein, iron, and zinc availability and projected climate change on global diets: a modelling study

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Appendix A1: IMPACT and the IMPACT system of models

The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) system of models links together the output of climate models, process-based crop simulation models, global hydrology models, and the IMPACT global economic model, a global partial equilibrium model for the agricultural sector (Figure A1.1). The IMPACT economic model simulates national and global markets of agricultural production, demand, and trade associated with 62 agricultural commodities across 158 countries and regions. For additional details on the IMPACT model please refer to the IMPACT model documentation (Robinson et al. 2015) and appendix A1 in Springmann et al., 2016 (pp2-13).

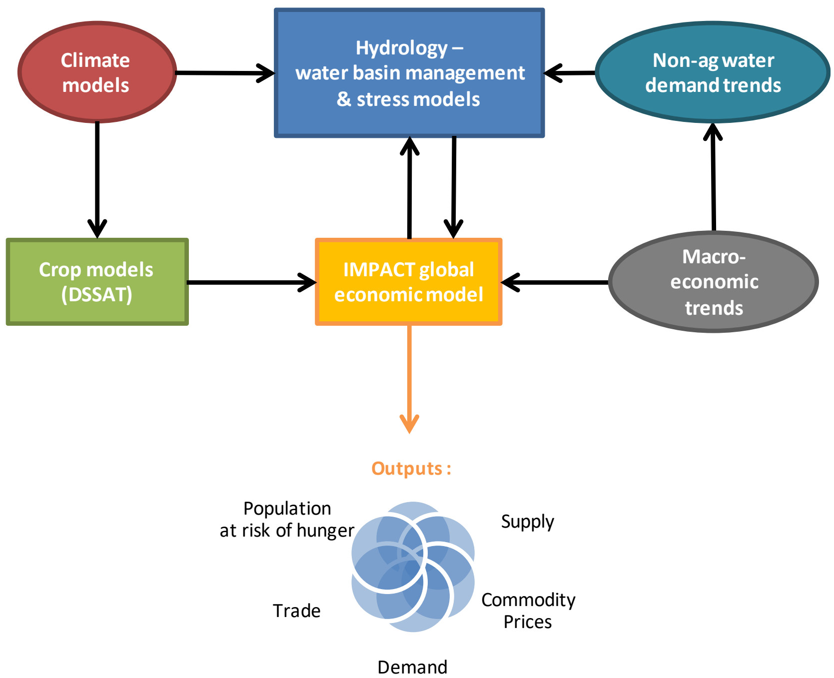

Figure A1.1 The IMPACT system of models. Modified from Robinson et al. 2015

The variability of outcomes in IMPACT is represented through the simulation of different scenarios based on the combination of four representative concentration pathways (RCPs; van Vuren et al, 2011) and five global circulation models. A thorough analysis of the variability in economic modeling projections across climate change scenarios and shared socioeconomic pathways (SSPs) is presented in Wiebe et al (2015).

GCMs used in this analysis:

GFDL-ESM2M	National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamic Laboratory	Dunne et al. 2012
HADGEM2-ES	Hadley Centre's Global Environment Model, version 2	Jones et al. 2011
IPSL-CM5A-LR	Institut Pierre Simon Laplace's ESM	Dufresne et al. 2013
MIROC-ESM	Model for Interdisciplinary Research on Climate	Watanabe et al. 2011
NorESM	Norwegian earth system model	Bentsen et al., 2012; Iversen et al., 2012

The effects of climate change on crop productivity, including the yield effects of changes in mean temperatures and precipitation and CO_2 fertilisation, are incorporated into the model through addition of an exogenous percentage adjustment to yields, defined by commodity and region. The values used to make these adjustments are based on results generated using the DSSAT model (Hoogenboom et al. 2012; Jones et al. 2003) combined with the water modeling components of the IMPACT model (Doorenbos and Kassam 1979, Robinson et al. 2015). Our CO_2 fertilisation adjustment affects only the mass of crops (yield) and is typically positive. In addition to that effect, we are separately making use of estimated percentage reductions in the proportion of iron, zinc, and protein contained within the edible portion of the affected crops based on Loladze (2014) and Myers et al. (2014; Extended Data Table 2) datasets.

Appendix A2: Mapping IMPACT commodities and nutrient coefficients

The "carbon nutrient penalty" is derived from percent changes in concentration of protein, iron, and zinc at a given elevated atmospheric CO_2 concentration (in this study, 541ppm and 487ppm representing projected atmospheric concertation in 2050 under RCP8.5 and RCP4.5, respectively). To determine the carbon nutrient penalty from both Loladze (2014) and Myers et al. (2014) datasets, the following steps and criteria were applied.

1. Only data derived from either free-air CO_2 enrichment (FACE) or open-top chambers (OTCs) experiments were used, with the exception of non-spinach vegetables in the Loladze dataset (the "Vegetables" category consists of FACE data for spinach and non-FACE/OTC data for carrot, radish, turnip, tomato, lettuce, and celery).
2. Only data for edible portions of food crops were used.
3. Carbon nutrient penalties were assigned by the following criteria:
    a. Where estimated nutrient impact data existed for a given crop with a statistical significance value of $p=0{\cdot}05$ or better, we used that data.
    b. Where the data for a given crop existed, but was not statistically significant, zero effects were assumed.
    c. Where data did not exist, the nutrient impact of the crop was determined by the average nutrient impact for that class of crop if available in the dataset (C3-legumes, C3-tubers, and C3-grasses).
    d. Averages were calculated for C3-legumes, C3-tubers, and C3-grasses, weighted by the inverse of the variance, or by sample size when variance is not available, for each crop included in the average. Either method gives more weight to larger (more precise) studies and are routinely used in meta-analytic studies.
    e. Where direct measurements for a C4 crop did not exist, the effect was assumed to be zero.
    f. For C3 crops that did not fall into one of the three group categories, the weighted average for all C3 crops was used in the case of zinc and iron effects. For protein, C3 crops that did not fall into one of the group categories used a weighted average of all non-legume C3 crops for protein effects.

Using the above protocol, the mapping from the Loladze and Myers datasets to the 56 consumed IMPACT crop commodities (see Robinson et al. 2015 for full list of commodities) is detailed in Table A2.1.

Table A2.1. Mapping IMPACT commodities to nutrient datasets

IMPACT commodities			Mapped to:	
Code	Type	Name	Loladze	Myers
cbarl	Cereals	Barley	Barley	Barley
cmaiz		Maize	C4-grasses	Maize
cmill		Millet	C4-grasses	C4-grasses
cocer		Other Cereals	C3-grasses	C3-grasses
crice		Rice	Rice	Rice
csorg		Sorghum	C4-grasses	C4-grasses
cwhea		Wheat	Wheat	Wheat
cbana	Fruits & Vegetables	Banana	C3-average	C3-average
cplnt		Plantain	C3-average	C3-average
ctemf		Temperate Fruit	C3-average	C3-average
csubf		Tropical Fruit	C3-average	C3-average
cvege		Vegetables	Vegetables	C3-average
cgrnd	Oils	Groundnut	C3-legumes	C3-legumes
ctols		Other Oilseeds	C3-average	C3-average
crpsd		Rapeseed	C3-average	C3-average
csoyb		Soybean	C3-legumes	Soybeans
csnfl		Sunflower	C3-average	C3-average
cbean	Pulses	Beans	C3-legumes	C3-legumes
cchkp		Chickpeas	C3-legumes	C3-legumes
ccowp		Cowpeas	C3-legumes	C3-legumes
clent		Lentils	C3-legumes	C3-legumes
copul		Other Pulses	C3-legumes	C3-legumes
cpigp		Pigeonpeas	C3-legumes	C3-legumes
ccass	Roots & Tubers	Cassava	C3-tubers	C3-tubers
corat		Other Roots	C3-tubers	C3-tubers
cpota		Potato	Potato	Potato
cswpt		Sweet Potato	C3-tubers	C3-tubers
cyams		Yams	C3-tubers	C3-tubers
csugr	Sugar	Sugar	C4-grasses	C4-grasses

Note that nlaverage values (Table A2.2) are used for protein for non-legumes. If no data is available, a value of zero is used for protein for legumes, as legumes are nitrogen fixers and nitrogen is used as a proxy for protein in this study.

Estimating carbon nutrient penalties at 541ppm and 487ppm

Carbon nutrient penalties (increased atmospheric CO_2 effects (%) on protein, iron, and zinc) were calculated for elevated atmospheric CO_2 concentrations of 541ppm (consistent with RCP8.5 in 2050; main results presented in manuscript and Table A2.2) and 487ppm (consistent with RCP4.5 in 2050; Table A2.3).

Values presented in the following tables represent interpolation to 541ppm and 487ppm under the assumption of a linear CO_2-nutrition trend, using actual mean values for ambient and elevated CO_2 levels observed in experiments for each crop group and nutrient. Although neither the Loladze (2014) nor Myers et al (2014) study derived an empirical linear relationship between rising atmospheric CO_2 concentrations and nutrient impacts, there is some indication of such linear relationships in wheat (Ziska et al. 2004) and goldenrod (non-edible) (Ziska et al. 2016) up to and exceeding atmospheric CO_2 levels of 550 ppm. Therefore, we believe this assumption is reasonable despite a lack of more thorough experimental evidence.

To estimate the distribution of potential nutrient losses under increased atmospheric CO_2 levels from individual crop types and from crop categories (e.g. C3 grasses), we first generated skew-normal distributions based on the data presented in Loladze (2014) and Myers et al. (2014). The average ambient and elevated CO_2 values for the Loladze (2014) dataset for iron, zinc, and protein in the edible portions of several crop types were 373ppm and 674ppm, respectively; the average ambient and elevated CO_2 values for Myers et al (2014) were 375ppm and 550ppm, respectively, based on an analysis which combined newly and previously performed FACE experiments.

To estimate the nutritional behavior of broader crop groups, we performed a weighted average of the constituent food distributions using as weights the inverse of the variance of each crop's nutritional response function. The foods used to construct each group's distribution, where available, is as follows:

- *C3 grasses*: wheat, rice, barley
- *C3 legumes*: field peas, soybeans
- *C3 average*: wheat, rice, barley, potato, field peas, soybeans
- *C3 non-legume average*: wheat, rice, barley, potato

Table A2.2. Effects (%) of atmospheric CO_2 concentration of 541ppm on nutrients (carbon nutrient penalty). 95% confidence bounds are shown in brackets ([lower, upper]). C3-average is the average of all C3 crops. C3-nlaverage is the non-legume average.

		Protein		Iron		Zinc	
Loladze	Wheat	-11·7	[-14·8, -8·9]	-6·7	[-9·2, -4·9]	-5·8	[-7·8, -4·1]
	Rice	-11·7	**[-17·6, -5·9]	-	-	-	-
	*Maize	-	-	-	-	-	-
	Barley	-7·2	**[-10·8, -3·6]	-	-	-13·4	[-18·6, -8·8]
	Potato	-4·7	[-7·5, -1·6]	-	-	-	-
	*Soybeans	-	-	-5·2	[-8·9, -1·5]	-4·7	[-6·1, -3·4]
	Vegetables	-3·2	[-5·2, -0·8]	-	-	-3·9	[-6·0, -1·5]
	C3-legumes	-	-	-5·2	[-8·9, -1·5]	-4·7	[-6·1, -3·4]
	C3-tubers	-4·7	[-7·5, -1·6]	-	-	-	-
	C3-grasses	-10·8	[-13·0, -8·9]	-5·8	[-9·1, -2·2]	-5·9	[-8·1, -4·0]
	C3-average			-5·2	[-8·9, -1·5]	-4·7	[-6·1, -3·4]
	C3-nlaverage	-5·8	[-7·2, -4·4]				
	C4-grasses	-	-	-	-	-	-
Myers	Wheat	-6·2	[-7·1, -5·1]	-5·2	[-6·5, -3·9]	-8·4	[-11, -5·3]
	Rice	-7·6	[-8·5, -6·6]	-4·6	[-6·9, -2·5]	-3·0	[-4·6, -1·5]
	Maize	-	-	-5·5	[-10·4, -0·4]	-	-
	Barley	-11·3	[-12·4, -10·1]	-10·0	[-11·5, -8·2]	-10·6	[-18·1, -2·6]
	Potato	-4·5	[-7·4, -1·5]	-	-	-	-
	Soybeans	-	-	-3·9	[-5·5, -2·4]	-4·8	[-6·2, -3·8]
	*Vegetables	-7·4	[-12, -4·6]	-5·0	[-10·9, -2·4]	-4·7	[-9·9, -1·9]
	C3-legumes	-	-	-3·9	[-5·8, -2·0]	-5·0	[-7·9, -3·7]
	C3-tubers	-4·5	[-7·4, -1·5]	-	-	-	-
	C3-grasses	-7·5	[-12, -5·3]	-5·6	[-11·1, -3·5]	-3·2	[-11·3, -1·5]
	C3-average			-5·0	[-10·9, -2·4]	-4·7	[-9·9, -1·9]
	C3-nlaverage	-7·4	[-12, -4·6]				
	C4-grasses	-	-	-5·5	[-10·4, -0·4]	-	-

* Specific crop data not available; values mapped to averaged crop type data (see Table A2.1)

** Confidence intervals constructed by using +/- 50% of point estimate

Table A2.3. Effects (%) of atmospheric CO_2 concentration of 487ppm on nutrients (carbon nutrient penalty). 95% confidence bounds are shown in brackets ([lower, upper]). C3-average is the average of all C3 crops. C3-nlaverage is the non-legume average.

		Protein		Iron		Zinc	
Loladze	Wheat	-7·9	[-10·0, -6·1]	-4·5	[-6·2, -3·3]	-3·9	[-5·3, -2·8]
	Rice	-8·0	**[-11·9, -4·0]	-	-	-	-
	*Maize	-	-	-	-	-	-
	Barley	-4·7	**[-7·1, -2·4]	-	-	-8·9	[-12·4, -5·9]
	Potato	-3·3	[-5·2, -1·1]	-	-	-	-
	*Soybeans	-	-	-3·5	[-6·1, -1·0]	-3·2	[-4·1, -2·3]
	Vegetables	-2·1	[-3·5, -0·5]	-	-	-2·5	[-3·9, -1·0]
	C3-legumes	-	-	-3·5	[-6·1, -1·0]	-3·2	[-4·1, -2·3]
	C3-tubers	-3·3	[-5·2, -1·1]	-	-	-	-
	C3-grasses	-7·3	[-8·8, -6·0]	-3·9	[-6·1, -1·5]	-4·0	[-5·5, -2·7]
	C3-average			-3·5	[-6·1, -1·0]	-3·2	[-4·1, -2·3]
	C3-nlaverage	-4·0	[-5·0, -3·0]				
	C4-grasses	-	-	-	-	-	-
Myers	Wheat	-4·2	[-4·7, -3·5]	-3·5	[-4·4, -2·7]	-5·6	[-7·5, -3·7]
	Rice	-5·1	[-5·8, -4·4]	-3·1	[-4·6, -1·8]	-1·9	[-3·0, -1·0]
	Maize	-	-	-3·7	[-7·0, -0·2]	-	-
	Barley	-7·6	[-8·4, -6·8]	-6·7	[-7·8, -5·5]	-7·4	[-12·3, -2·2]
	Potato	-2·9	[-4·7, -0·9]	-	-	-	-
	Soybeans	-	-	-2·7	[-3·8, -1·6]	-3·3	[-4·1, -2·5]
	*Vegetables	-5·0	[-8·1, -3·1]	-3·4	[-7·4, -1·6]	-3·2	[-6·7, -1·3]
	C3-legumes	-	-	-2·6	[-3·9, -1·3]	-3·4	[-5·3, -2·5]
	C3-tubers	-2·9	[-4·7, -0·9]	-	-	-	-
	C3-grasses	-5·0	[-8·1, -3·6]	-3·8	[-7·5, -2·4]	-2·2	[-7·6, -1·0]
	C3-average			-3·4	[-7·4, -1·6]	-3·2	[-6·7, -1·3]
	C3-nlaverage	-5·0	[-8·1, -3·1]				
	C4-grasses	-	-	-	-	-	-

* Specific crop data not available; values mapped to averaged crop type data (see Table A2.1)

** Confidence intervals constructed by using +/- 50% of point estimate

Appendix A3. Nutrient Requirements

We account for differences in the diet-controlled bioavailability in zinc by sorting countries into one of three bioavailability categories designated low, medium, or high bioavailability, based on the phytate to zinc molar ratio of the diet, as phytate acts an inhibitor to zinc absorption by binding to zinc and making it inaccessible to the body. Country phytate to zinc molar ratios were taken from Wessells et al. (2012), and the criteria linking phytate-zinc ratios to bioavailability categories were provided by the Joint FAO/WHO (2011) alongside their RNI values (Table A3.1).

Table A3.1. Criteria for sorting countries into zinc bioavailability groupings based on phytate content of the diet.

Bioavailability	Phytate:zinc molar ratio
Low	>15
Medium	5-15
High	<5

For iron, the relationship between absorption and diet is more complicated, depending on a broader array of dietary factors that control bioavailability: the amount of iron present as heme iron (the type present in animal foods and more easily absorbed), as well as ascorbic acid, animal proteins, and several other foods and nutrients which exert a smaller influence. Therefore, we used the similar criteria as Golden et al. (2016) to categorize the diet of each country into one of four bioavailability groups for which RNIs were provided, based on the meat, fruit, and vegetable intake of diets. The criteria were informed by previous analyses by Hallberg and Hulthén (1991) and Hurrell and Egli (2010) and shown below in Table A3.2.

Table A3.2. Criteria for sorting countries into iron bioavailability groupings based on dietary factors.

Iron bioavailability	Meat intake (g/day)	Fruit and vegetable intake (g/day)
5%	<50	any
10%	50-150	<300
12%	50-150	>300
15%	>150	>300

Protein requirements, unlike for iron and zinc, are determined by the weight of the individual rather than simply by age and sex, and FAO-WHO recommendations for protein requirements are given as grams of protein per kilogram of body mass per day. To estimate the average weight of each age and sex group globally, we used data estimating the BMI of adults from the World Health Organization (2014) and converted them to average weight using heights estimated by the NCD-RisC group (2014). To estimate the weight of adolescents and children, WHO curves (United Nations 2015; WHO 2007a,b) were used to translate adult anthropometric measurements to younger age groups. For children under 5, for whom similar growth curves are unavailable, the median weight was used instead (WHO 2007c).

For all nutrients, requirements are higher for pregnant and lactating women compared to non-pregnant or non–lactating women of the same age. To estimate the population size of pregnant and lactating women, we used the age-specific fertility rate for 2015 from the UN World Population Prospects (United Nations 2015), multiplied by the average duration of labor: 40 weeks. To estimate the number of lactating mothers, we multiplied the birth rate by the current median duration of breastfeeding by country, assembled using a combination of country reports from the WHO Global Data Bank on Infant and Young Child Feeding (WHO 2017) and the World Breastfeeding Trends Initiative (WBTi 2017). Countries without data were interpolated using a regional average. Finally, the age-sex-specific requirements for each nutrient were summed to country population-weighted averages using demographic sizes in 2015 based on UN data (United Nations 2015), combined with estimated populations of pregnant and lactating women.

Appendix A4. Nutrient Supply using the GENuS Model

The Global Expanded Nutrient Supply (GENuS) model was used to provide estimates of the availability of protein, zinc, and iron for each country. The full methodology of GENuS (Smith et al. 2016) and all datasets Smith (2016), are publicly available, but a brief summary is provided here for reference.

GENuS begins by estimating the per capita availability of 225 foods in the diet by using a combination of the FAO food balance sheets — which provide estimates on the per capita availability of roughly 100 foods in most countries globally — and additional production and trade data provided by the FAO which were used to approximately replicate the food balance sheet methodology (total quantity of food production and imports minus exports and uses other than human consumption) and increase the number of described foods to 221. For four major grains (wheat, maize, millet and sorghum), because the nutrient profile of the refined grain differs so markedly from that of the whole grain, and also because these grains comprise large portions of the diet globally, we took additional steps to estimate the quantity of refined flour consumed by using the proportion of grain milled and the extraction percentage for each country (Wessells et al., 2012), bringing the total number of foods included to 225. Non-edible portions of each food (e.g., bones, peels, seeds), were removed at this stage, leaving the edible per capita supply of each food as the intermediate output. Twenty-three countries without sufficient data to allow for the expansion of foods described were removed from the dataset, leaving 152 countries remaining.

Per capita food supplies for each country were then paired with one of six regional food composition tables — USA, West Africa, India, Northeast Asia, Southeast Asia, and Latin America — to infer the nutrient supply across 23 nutrients by food and country. All foods in each table that were suitable matches for a GENuS food category were included in our analysis, and Monte Carlo simulations (N=1,000) were run to estimate the uncertainty inherent in our estimates of the nutrients provided by each country's diet. The median and 95% uncertainty intervals of the Monte Carlo simulations were reported and included as inputs in this analysis.

Appendix A5. Supplementary Results

The following tables of IMPACT output results, including 95% confidence ranges are available at: https://github.com/IFPRI/Mid-century-eCO2-fx-protein-iron-zinc.

Table A5.1. Projected protein availability. Results for 2010 and 2050, with and without climate change (including CO_2 fertilisation), are shown by country and region for RCP8.5 using Loladze (2014) and Myers et al (2014) datasets (g/person/day). Region values are weighted averages.

			2050-nutrient scenarios	
	2010	**2050-climate**	**(Loladze)**	**(Myers et al.)**
Global	**95·09**	**111·82**	**107·27**	**108·54**
East Asia & Pacific	**104·81**	**134·15**	**129·23**	**130·4**
Australia	126·54	137·51	133·68	135·05
Cambodia	63·07	72	68·2	69·31
China	117·43	154·36	148·92	150·01
Fiji	93·59	137·4	129·62	132·47
Indonesia	72·6	104·23	99·31	100·9
Japan	108·28	117·01	113·78	114·81
Laos	69·51	83·25	79·22	80·13
Malaysia	109·76	132·89	126·68	129
Mongolia	92·73	162·2	155·78	158·46
Myanmar	85·13	191·19	187·41	188·01
New Zealand	120·37	130·62	126·1	127·61
North Korea	67·64	64·06	60·85	61·59
Other Indian Ocean	47·18	64·08	60·73	61·94
Other Pacific Ocean	65·36	90·71	86·84	88·05
Other Southeast Asia	130·27	131·74	126·89	128·36
Papua New Guinea	39·73	56·07	54·31	53·95
Philippines	72·19	86·79	82·52	83·83
Solomon Islands	61·64	78·29	74·07	74·97
South Korea	111·74	127·57	123·25	124·22
Thailand	75	94·03	90·05	91·12
Timor L'Este	64·47	84·33	81·55	82·4
Vanuatu	80·46	109·78	104·68	105·54
Vietnam	79·16	105·78	101·57	102·85
Europe	**127·99**	**134·83**	**129·27**	**131·32**
Albania	124·47	141·21	133·15	136·29
Austria	129·35	136·66	131·25	133·26
Baltic States	122·96	136·32	130·85	132·66
Belgium-Luxembourg	126·15	126·78	121·46	123·45
Bulgaria	105·24	124·94	118·62	121·15
Croatia	102·48	111·67	106·07	108·35
Cyprus	96·16	95·72	92·8	93·67
Czech Republic	118·48	135·92	129·77	132·19
Denmark	147·53	153·1	146·99	149·28
Finland	126·02	130·9	125·81	127·66
France	134·74	135·15	130·16	132·03
Germany	119·21	122·85	118·05	119·82
Greece	142·66	156·49	149·08	151·71
Hungary	115·22	131·31	125·58	127·77

Iceland	110·81	119·12	115·16	116·59
Ireland	137·27	144·42	138·65	140·81
Italy	144·95	151·74	144·39	147·15
Netherlands	122·78	124·85	120·83	122·18
Norway	125·32	127·67	122·08	124·09
Other Balkans	68·04	78·81	75·25	76·5
Poland	125·33	138·47	131·51	133·98
Portugal	141·12	146·2	140·34	142·36
Romania	136·31	154·07	146·56	149·39
Slovakia	101·23	114·79	108·87	111·17
Slovenia	126·34	137·95	133·03	134·84
Spain	140·09	140·47	135·97	137·51
Sweden	130·52	135·34	130·49	132·27
Switzerland	115·32	122·02	116·81	118·84
UK	129·37	137·6	132·06	134·11
Former Soviet Union	**116·71**	**131·16**	**123·52**	**126·51**
Armenia	107·28	131·25	122·91	125·92
Azerbaijan	130·34	136·35	125·4	130·04
Belarus	119·54	128·83	123·69	125·26
Georgia	108·06	139·32	130·68	134·2
Kazakhstan	132·52	157·12	147·54	151·37
Kyrgyzstan	109·43	132·73	125·29	128·04
Moldova	97·44	125·46	117·74	120·81
Russia	119·7	131·82	124·98	127·59
Tajikistan	89·36	106·18	97·12	100·83
Turkmenistan	130·12	156·43	146·83	150·72
Ukraine	114·14	126·15	119·51	122·02
Uzbekistan	102·61	123	113·36	117·41
Latin America & the Caribbean	**98·18**	**110·76**	**107·73**	**108·69**
Argentina	120·28	130·53	125·49	127·5
Belize	90·11	100·41	96·79	97·99
Bolivia	77·05	100·82	97·51	98·51
Brazil	110·14	130·22	126·93	128·03
Chile	111·59	125·6	120·56	122·3
Colombia	76·84	83·28	80·92	81·57
Costa Rica	87·31	97·67	94·67	95·58
Cuba	87·11	101·05	96·95	98·03
Dominican Republic	70·79	82·42	79·8	80·49
Ecuador	72·53	89·71	86·55	87·41
El Salvador	80·07	88·19	86·61	86·96
Guatemala	72·3	85·26	83·31	83·8
Guyanas	64·85	71·99	68·26	69·47
Haiti	46·68	58·45	55·9	56·65
Honduras	75·79	87·85	85·84	86·44
Jamaica	85·29	116·46	112·13	113·55
Mexico	108·26	116·55	114·37	114·96
Nicaragua	65·72	79·06	76·7	77·56
Other Caribbean	90·79	118·12	113·6	115·25
Panama	85·16	102·85	99·38	100·55
Paraguay	82·16	95·64	93·89	94·25
Peru	77·81	90·51	86·39	87·51
Uruguay	109·2	122·72	117·39	119·51
Venezuela	83·65	86·81	84·24	85·13
Middle East & North Africa	**113·23**	**124·31**	**116·97**	**119·7**

Algeria	118·68	124·1	115·31	118·58
Egypt	118·84	140·59	133·16	135·94
Iran	113·86	121·33	113·55	116·43
Iraq	69·36	76·45	69·63	72·22
Israel	161·35	180·77	173·27	175·95
Jordan	102·46	124·26	117·47	119·95
Lebanon	124·48	142·28	135·88	137·98
Libya	122·97	133·21	124·39	127·45
Mauritania	92·17	113·06	106·84	109·48
Morocco	124·22	137·1	128·2	130·93
Palestine	95·64	151·67	142·87	146·08
Rest of Arabia	121·02	132·47	125·98	128·32
Saudi Arabia	95·88	102·79	97·71	99·59
Syria	108·09	133·9	125·82	128·78
Tunisia	127·43	153·39	143·46	147·02
Turkey	133·22	156·43	148·16	151·39
Yemen	68·63	73·28	68·67	70·63
North America	**148·95**	**156·19**	**151·79**	**153·27**
Canada	138·03	142·29	137·24	139·04
Greenland	n.d.	n.d.	n.d.	n.d.
USA	150·2	157·82	153·49	154·93
South Asia	**65·87**	**94·51**	**89·53**	**90·69**
Afghanistan	67·9	82·78	76·63	79·19
Bangladesh	62·92	82·45	76·86	78·71
Bhutan	75·11	97·36	94·86	95·39
India	65·2	97·37	92·56	93·39
Nepal	66·64	102·38	97·46	98·98
Pakistan	72·29	89·18	83·87	86·08
Sri Lanka	72·33	95	89·97	91·53
Sub-Saharan Africa	**66·4**	**83·15**	**80·82**	**81·32**
Angola	68·66	75·12	72·29	73·25
Benin	68·08	84·4	82·12	82·54
Botswana	65·47	81·7	79·38	80·14
Burkina Faso	90·52	114·02	113·05	113·3
Burundi	47·11	73·43	71·79	71·79
Cameroon	63·2	77·48	75·36	75·65
Central African Rep.	52·16	90·35	88·52	88·7
Chad	75·55	96·15	94·22	94·71
Congo	54·26	78·12	74·23	75·48
Djibouti	58·24	82·47	77·92	79·74
DRC	23·22	32·94	32·3	32·32
Equatorial Guinea	43·17	39·6	38·58	38·45
Eritrea	48·68	64·12	60·99	62·15
Ethiopia	68·46	91·79	87·53	88·31
Gabon	88·77	94·33	90·06	91·37
Gambia	61·62	75·58	73·45	74·16
Ghana	67·8	80·44	77·63	78·06
Guinea	55·74	85·85	80·89	81·95
Guinea-Bissau	54·77	68·31	65·33	66·14
Ivory Coast	55·75	67·03	63·74	64·38
Kenya	64·95	81·52	79·32	79·96
Lesotho	76·81	89·45	86·74	87·72
Liberia	46·43	68·15	64·56	65·56
Madagascar	49·12	63·04	59·68	60·67

Malawi	65·91	72·56	71·44	71·53
Mali	75·13	89·2	87·33	87·81
Mozambique	48·72	67·5	65·59	66·14
Namibia	85·8	108·25	104·79	105·99
Niger	92·13	122·66	121·56	121·73
Nigeria	77·18	90·07	87·52	88·02
Other Atlantic	52·27	81·15	78·06	78·94
Rwanda	56·16	85·71	83·53	83·68
Senegal	70·49	79·83	76·45	77·55
Sierra Leon	57·49	67·28	64·26	65·1
Somalia	40·49	86·24	85·83	85·72
South Africa	94·91	116·92	113·06	114·59
Sudan	77·1	95·33	93·57	94·01
Swaziland	79·86	97·15	94·3	95·26
Tanzania	67·66	84·2	82·34	82·65
Togo	62·05	78·3	76·35	76·79
Uganda	62·03	80·42	78·71	78·86
Zambia	55·33	80·53	78·88	79·35
Zimbabwe	59·15	90·78	89·25	89·71

Table A5.2. Projected iron availability. Results for 2010 and 2050, with and without climate change (including CO_2 fertilisation), are shown by country and region for RCP8.5 using Loladze (2014) and Myers et al (2014) datasets (mg/person/day). Region values are weighted averages.

			2050-nutrient scenarios	
	2010	**2050-climate**	**(Loladze)**	**(Myers et al.)**
Global	**23·78**	**28·5**	**27·7**	**27·39**
East Asia & Pacific	**27·08**	**32·75**	**32·03**	**31·61**
Australia	20·18	21·63	21·04	21·05
Cambodia	12·68	14·36	14·17	13·8
China	32·45	40·37	39·48	38·96
Fiji	23·24	33·15	31·8	31·9
Indonesia	16·73	22·7	22·24	21·82
Japan	24·11	25·39	24·75	24·63
Laos	14·61	16·95	16·8	16·29
Malaysia	20·23	25·68	24·8	24·75
Mongolia	28·14	46·65	45·27	45·48
Myanmar	16·73	23·83	23·42	23·01
New Zealand	22·9	25·11	24·37	24·35
North Korea	20·47	19·72	19·33	18·87
Other Indian Ocean	12·53	16·52	15·92	15·88
Other Pacific Ocean	16·25	21·76	21·09	21·09
Other Southeast Asia	22·97	23·5	23·02	22·77
Papua New Guinea	19·37	26·64	25·97	25·96
Philippines	13·7	15·9	15·58	15·32
Solomon Islands	22·98	28·92	28·18	28·11
South Korea	28·56	31·87	31·14	30·74
Thailand	15·37	18·85	18·47	18·2
Timor L'Este	17·03	20·97	20·74	20·22
Vanuatu	31·8	40·44	39·35	39·25
Vietnam	15·4	18·44	18·11	17·79
Europe	**22·73**	**24·42**	**23·55**	**23·58**
Albania	25·12	29·3	27·97	28·06
Austria	22·23	24·52	23·65	23·69
Baltic States	22·2	23·88	23·08	23·03
Belgium-Luxembourg	22·62	23·73	22·93	22·94
Bulgaria	21·32	25·4	24·39	24·43
Croatia	19·06	21·06	20·18	20·25
Cyprus	17	17·23	16·7	16·71
Czech Republic	21·9	25·31	24·33	24·46
Denmark	24·95	26·71	25·79	25·87
Finland	18·63	20·18	19·42	19·46
France	23·36	24·02	23·26	23·25
Germany	19·89	21·14	20·4	20·41
Greece	29·07	32·2	30·98	31·03
Hungary	21·78	24·77	23·86	23·92
Iceland	17·82	20·09	19·47	19·54
Ireland	23·1	24·83	23·93	24
Italy	26·35	28·31	27·13	27·23
Netherlands	18·78	20·07	19·46	19·48
Norway	21·55	22·41	21·58	21·61
Other Balkans	14·71	17·25	16·66	16·55
Poland	23·89	26·32	25·3	25·32
Portugal	24·5	26·42	25·56	25·52

Romania	27·23	30·72	29·58	29·51
Slovakia	19·72	22·18	21·28	21·36
Slovenia	22·78	25·15	24·37	24·27
Spain	23·37	24·31	23·56	23·6
Sweden	18·92	20·55	19·81	19·86
Switzerland	19·08	21·2	20·4	20·44
UK	23·18	25·16	24·3	24·37
Former Soviet Union	**24·06**	**27·25**	**26·11**	**26·2**
Armenia	25·15	30·15	28·91	28·88
Azerbaijan	32·21	33·35	31·67	31·89
Belarus	22·44	23·05	22·35	22·29
Georgia	23·64	29·76	28·45	28·51
Kazakhstan	27·13	32·43	31·03	31·15
Kyrgyzstan	24·3	29·2	28·11	28·05
Moldova	20·98	27·05	25·88	25·96
Russia	23·71	26·28	25·26	25·35
Tajikistan	23·04	26·77	25·42	25·49
Turkmenistan	28·34	32·85	31·43	31·57
Ukraine	23·02	25·01	24·04	24·08
Uzbekistan	23·41	28·25	26·76	26·95
Latin America & the Caribbean	**20·86**	**23·18**	**22·53**	**22·34**
Argentina	24·61	26·83	25·88	25·92
Belize	20·49	22·67	21·84	21·76
Bolivia	17·43	21·91	21·38	21·18
Brazil	21·88	24·83	24·08	24
Chile	24·24	27·73	26·79	26·7
Colombia	15·98	17·51	17·09	16·89
Costa Rica	17·35	19·48	18·93	18·81
Cuba	23·56	27·43	26·66	26·38
Dominican Republic	14·41	16·69	16·21	16·11
Ecuador	13·77	17·49	16·94	16·88
El Salvador	20·6	22·65	22·18	21·7
Guatemala	17·9	20·85	20·34	19·99
Guyanas	13·69	15·68	15·18	15·09
Haiti	12·28	15·47	15·01	14·87
Honduras	17·18	19·76	19·27	18·95
Jamaica	17·65	23·17	22·53	22·47
Mexico	24·9	26·59	25·95	25·55
Nicaragua	14·28	17·03	16·55	16·33
Other Caribbean	18·95	23·61	22·88	22·89
Panama	16·14	19·05	18·54	18·4
Paraguay	19	21·92	21·44	21·18
Peru	19	22·65	21·96	21·79
Uruguay	24·65	27·71	26·72	26·69
Venezuela	17·38	18·44	17·98	17·75
Middle East & North Africa	**27·64**	**29·06**	**27·89**	**27·84**
Algeria	29·48	30·78	29·4	29·39
Egypt	28·95	32·25	31·01	30·85
Iran	27·91	28·95	27·77	27·78
Iraq	18·22	20·05	19·09	19·08
Israel	31·51	36·2	34·96	34·94
Jordan	23·39	27·51	26·42	26·47
Lebanon	28·27	31·49	30·35	30·43
Libya	30·43	32·85	31·5	31·42

Mauritania	26·96	35·67	34·03	34·07
Morocco	32·4	35·27	33·95	33·54
Palestine	22·39	33·23	31·86	31·93
Rest of Arabia	26·54	28·71	27·76	27·73
Saudi Arabia	22·68	24·03	23·22	23·13
Syria	26·66	32·88	31·52	31·55
Tunisia	31·87	38·15	36·51	36·55
Turkey	32·94	33·87	32·44	32·52
Yemen	16·82	17·82	17·06	17·02
North America	**24·52**	**25·82**	**25·1**	**25·06**
Canada	24·75	26·54	25·68	25·67
Greenland	n.d.	n.d.	n.d.	n.d.
USA	24·5	25·73	25·03	24·99
South Asia	**17·31**	**26·79**	**26·02**	**25·61**
Afghanistan	23·19	26·95	25·65	25·72
Bangladesh	13·9	18·09	17·74	17·4
Bhutan	23·33	29·49	28·97	28·37
India	17·21	28·4	27·68	27·14
Nepal	22·82	33·81	32·95	32·52
Pakistan	20·61	25·29	24·12	24·21
Sri Lanka	18·98	27·35	26·23	26·2
Sub-Saharan Africa	**25·71**	**32·98**	**32·14**	**31·55**
Angola	20·6	23·55	22·97	22·65
Benin	21·92	26·29	25·92	25·41
Botswana	22·99	29·17	28·33	28·09
Burkina Faso	36·74	41·28	40·81	39·32
Burundi	17·75	26·23	25·45	25·36
Cameroon	21·91	26·77	26·19	25·68
Central African Rep.	18·4	27·8	27·18	26·89
Chad	43·82	50·48	48·71	48
Congo	17·36	23·08	22·28	22·32
Djibouti	17·58	21·76	20·79	20·85
DRC	8	10·18	9·98	9·91
Equatorial Guinea	15·24	15·92	15·73	15·74
Eritrea	23·1	32·79	31·52	31·07
Ethiopia	49·88	83·09	79·69	78·4
Gabon	22·63	25·63	24·79	24·72
Gambia	24·02	28·06	27·63	26·71
Ghana	23·23	27·26	26·73	26·42
Guinea	24·16	48·03	46·08	45·81
Guinea-Bissau	21·39	26·5	26·01	25·42
Ivory Coast	20·51	25·78	25·31	25·02
Kenya	18·18	23·37	22·76	22·35
Lesotho	30·35	38·81	37·51	36·91
Liberia	15·91	20·12	19·57	19·43
Madagascar	13·92	16·8	16·56	16·24
Malawi	22·17	23·47	23·09	22·53
Mali	28·93	32·43	31·98	30·9
Mozambique	19·23	23·24	22·76	22·51
Namibia	33·27	40·6	39·66	39·19
Niger	43·53	49·08	48·48	46·74
Nigeria	30·05	33·42	32·86	32·12
Other Atlantic	16·39	23·03	22·3	22·15
Rwanda	22·95	33·88	32·91	32·76

Senegal	21·73	24·19	23·74	23·1
Sierra Leon	19·72	24·63	23·87	23·68
Somalia	6·29	11·13	11	10·82
South Africa	23·59	27·17	26·4	26
Sudan	22·11	26·81	26·19	25·65
Swaziland	22·54	26·97	26·25	25·98
Tanzania	21·87	26·07	25·42	25·11
Togo	20·49	24·03	23·68	23·09
Uganda	22·82	26·58	25·88	25·61
Zambia	18·1	26·28	25·76	25·13
Zimbabwe	18·14	24·79	24·29	23·64

Table A5.3. Projected zinc availability Results for 2010 and 2050, with and without climate change (including CO_2 fertilisation), are shown by country and region for RCP8.5 using Loladze (2014) and Myers et al (2014) datasets (mg/person/day). Region values are weighted averages.

			2050-nutrient scenarios	
	2010	2050-climate	(Loladze)	(Myers et al.)
Global	**14·52**	**17·17**	**16·75**	**16·59**
East Asia & Pacific	**15·65**	**19·57**	**19·16**	**18·97**
Australia	19·54	20·98	20·6	20·46
Cambodia	6·6	8·32	8·21	8·13
China	18·72	23·75	23·23	22·99
Fiji	16·8	24·33	23·54	23·23
Indonesia	9·28	14·08	13·8	13·66
Japan	14·8	15·74	15·44	15·3
Laos	7·25	9·54	9·41	9·33
Malaysia	13·62	18·64	18·09	17·92
Mongolia	19·85	37·03	36·42	36·15
Myanmar	8·7	14·44	14·18	14·1
New Zealand	18·57	20·7	20·22	20·06
North Korea	11·61	11·17	10·94	10·8
Other Indian Ocean	7·13	9·59	9·31	9·18
Other Pacific Ocean	10·69	14·84	14·47	14·33
Other Southeast Asia	16·92	17·65	17·29	17·2
Papua New Guinea	7·71	11·28	11	10·99
Philippines	7·99	10·29	10·09	9·98
Solomon Islands	11·07	14·37	14·01	13·89
South Korea	16·97	19·79	19·37	19·19
Thailand	8·04	11·05	10·82	10·72
Timor L'Este	11·27	14·18	14·06	13·95
Vanuatu	14·32	19·47	18·93	18·8
Vietnam	8·44	11·91	11·7	11·59
Europe	**19·59**	**20·91**	**20·33**	**20·12**
Albania	20·39	23·31	22·49	22·14
Austria	19·82	21·33	20·76	20·6
Baltic States	18·83	20·13	19·49	19·36
Belgium-Luxembourg	18·99	19·61	19·08	18·86
Bulgaria	17·34	20·33	19·68	19·41
Croatia	15·99	17·45	16·9	16·67
Cyprus	14·06	14·2	13·87	13·76
Czech Republic	18·32	20·75	20·12	19·91
Denmark	22·62	23·78	23·16	22·99
Finland	18·6	19·6	19·04	18·93
France	20·4	20·98	20·49	20·28
Germany	18·09	19·05	18·55	18·41
Greece	23·2	25·52	24·75	24·46
Hungary	17·12	19·18	18·6	18·36
Iceland	16·98	18·57	18·17	18·03
Ireland	21·15	22·57	21·98	21·78
Italy	23·1	24·63	23·85	23·53
Netherlands	17·54	18·3	17·88	17·73
Norway	19·59	20·17	19·54	19·39
Other Balkans	11·25	13·02	12·63	12·48
Poland	19·64	21·55	20·77	20·62
Portugal	20·46	21·92	21·34	21·12
Romania	22·1	24·66	23·9	23·59

Slovakia	15·9	17·73	17·11	16·91
Slovenia	20·07	21·83	21·31	21·14
Spain	19·78	20·47	19·98	19·8
Sweden	19·13	20·17	19·66	19·51
Switzerland	17·72	19·13	18·59	18·39
UK	19·7	21·28	20·72	20·52
Former Soviet Union	**19·17**	**21·55**	**20·79**	**20·49**
Armenia	18·65	22·61	21·76	21·42
Azerbaijan	24·01	24·87	23·8	23·33
Belarus	18·95	19·52	18·96	18·89
Georgia	19·13	24·25	23·33	22·99
Kazakhstan	22·72	26·65	25·69	25·31
Kyrgyzstan	19·69	24	23·26	22·95
Moldova	16·2	20·5	19·71	19·41
Russia	18·8	20·5	19·83	19·57
Tajikistan	17·24	20·51	19·54	19·18
Turkmenistan	23·85	28·66	27·74	27·32
Ukraine	18·31	19·72	19·04	18·82
Uzbekistan	19	22·76	21·81	21·39
Latin America & the Caribbean	**16·23**	**17·95**	**17·59**	**17·46**
Argentina	21·77	23·28	22·69	22·42
Belize	14·3	15·73	15·32	15·14
Bolivia	13·84	17·66	17·32	17·18
Brazil	18·19	20·66	20·27	20·12
Chile	19·33	21·91	21·28	21·02
Colombia	12·75	13·78	13·54	13·44
Costa Rica	13·5	15·07	14·77	14·64
Cuba	14·62	16·76	16·33	16·13
Dominican Republic	10·54	12·08	11·85	11·73
Ecuador	11·6	14·18	13·9	13·77
El Salvador	12·63	13·82	13·57	13·5
Guatemala	12·08	14·02	13·72	13·64
Guyanas	10·77	12·22	11·9	11·72
Haiti	8·23	10·2	9·95	9·83
Honduras	11·96	13·67	13·42	13·32
Jamaica	12·5	16·45	16·07	15·91
Mexico	17·49	18·75	18·41	18·35
Nicaragua	10·57	12·46	12·23	12·11
Other Caribbean	13·78	17·42	16·95	16·78
Panama	13·93	16·52	16·24	16·09
Paraguay	13·85	15·75	15·49	15·42
Peru	12·94	15·05	14·63	14·46
Uruguay	19·95	22·13	21·52	21·24
Venezuela	13·34	14·22	13·94	13·82
Middle East & North Africa	**19·52**	**20·68**	**19·9**	**19·61**
Algeria	21·46	22·41	21·39	21·06
Egypt	20·1	22·67	21·94	21·63
Iran	19·2	20·17	19·41	19·08
Iraq	12·78	14·09	13·42	13·14
Israel	24·52	27·83	27·03	26·72
Jordan	17·07	20·31	19·62	19·33
Lebanon	20·88	24·08	23·36	23·11
Libya	21·72	23·67	22·65	22·31
Mauritania	12·83	17·01	16·52	16·34

Morocco	22·96	25·28	24	23·75
Palestine	16·54	25·3	24·36	24·1
Rest of Arabia	19·56	21·31	20·69	20·41
Saudi Arabia	15·91	16·95	16·46	16·28
Syria	18·99	23·38	22·52	22·18
Tunisia	22·21	26·56	25·43	25·03
Turkey	22·85	23·56	22·68	22·33
Yemen	11·99	12·78	12·31	12·11
North America	**22·54**	**23·58**	**23·1**	**22·94**
Canada	21·16	22·15	21·61	21·41
Greenland	n.d.	n.d.	n.d.	n.d.
USA	22·7	23·74	23·27	23·11
South Asia	**9·73**	**12·87**	**12·49**	**12·32**
Afghanistan	12·86	15·75	15·15	14·89
Bangladesh	6·34	9·02	8·8	8·66
Bhutan	14·53	18·35	18·05	18
India	9·62	12·62	12·27	12·11
Nepal	12·72	19·09	18·71	18·49
Pakistan	11·94	14·89	14·38	14·15
Sri Lanka	16·08	18·92	18·23	18·06
Sub-Saharan Africa	**11·58**	**14·78**	**14·5**	**14·46**
Angola	10·64	12·03	11·81	11·73
Benin	11·73	14·4	14·22	14·15
Botswana	9·53	12·2	12·01	11·96
Burkina Faso	17·39	21·44	21·25	21·21
Burundi	8·61	13·05	12·69	12·65
Cameroon	11·17	13·82	13·52	13·46
Central African Rep.	9·79	16·51	16·32	16·29
Chad	14·54	17·88	17·49	17·53
Congo	8·12	11·19	10·9	10·79
Djibouti	9·12	13·1	12·77	12·63
DRC	4	5·27	5·18	5·17
Equatorial Guinea	6·56	6·94	6·85	6·85
Eritrea	8·1	11·06	10·67	10·64
Ethiopia	12·92	18·82	17·86	18·05
Gabon	11·05	12·69	12·43	12·31
Gambia	10·44	12·81	12·67	12·59
Ghana	10·61	12·99	12·82	12·76
Guinea	9·05	15·51	15·07	15·06
Guinea-Bissau	9·54	12·09	11·98	11·9
Ivory Coast	9·86	12·26	12·11	12·03
Kenya	10·41	13·24	12·99	12·92
Lesotho	12·9	15·29	15·01	14·99
Liberia	7·49	10·15	9·96	9·85
Madagascar	8·33	10·58	10·49	10·37
Malawi	11·02	12·03	11·87	11·85
Mali	14·22	16·49	16·32	16·26
Mozambique	8·71	11·8	11·69	11·64
Namibia	12·51	16·59	16·33	16·27
Niger	19·88	25·37	25·1	25·06
Nigeria	14·82	17·38	17·11	17·05
Other Atlantic	7·42	11·64	11·42	11·33
Rwanda	10·07	14·91	14·56	14·51
Senegal	11·44	13·65	13·45	13·32

Sierra Leon	7·7	9·21	9·04	8·93
Somalia	6·52	14·49	14·39	14·39
South Africa	13·54	16·64	16·35	16·24
Sudan	12·69	16·27	16·05	15·99
Swaziland	12·04	14·73	14·52	14·44
Tanzania	10·99	13·47	13·23	13·17
Togo	10·99	13·67	13·49	13·43
Uganda	10·53	13·18	12·92	12·88
Zambia	8·93	12·82	12·66	12·62
Zimbabwe	9·58	14·77	14·54	14·51

Table A5.4. Nutrient availability under RCP4.5 by region. Results in 2010 and 2050, with and without climate change (including CO_2 fertilisation), are shown by region using Loladze (2014) and Myers et al (2014) datasets.

			2050-nutrient scenarios	
	2010	**2050-climate**	**(Loladze)**	**(Myers et al.)**
Protein consumption (g/person/day)				
Global	95·09	112	108·92	109·8
East Asia & Pacific	104·81	134·24	130·9	131·71
Europe	127·99	134·85	131·08	132·48
Former Soviet Union	116·71	131·13	125·95	128
Latin America & the Caribbean	98·18	111·01	108·95	109·61
Middle East & North Africa	113·23	124·31	119·34	121·2
North America	148·95	156·23	153·25	154·26
South Asia	65·87	94·64	91·27	92·07
Sub-Saharan Africa	66·4	83·7	82·12	82·48
Iron consumption (mg/person/day)				
Global	23·78	28·54	28·01	27·77
East Asia & Pacific	27·08	32·75	32·27	31·95
Europe	22·73	24·41	23·83	23·83
Former Soviet Union	24·06	27·23	26·47	26·51
Latin America & the Caribbean	20·86	23·23	22·8	22·65
Middle East & North Africa	27·64	29·05	28·27	28·22
North America	24·52	25·82	25·33	25·3
South Asia	17·31	26·83	26·31	25·99
Sub-Saharan Africa	25·71	33·19	32·63	32·21
Zinc consumption (mg/person/day)				
Global	14·52	17·2	16·92	16·84
East Asia & Pacific	15·65	19·59	19·31	19·22
Europe	19·59	20·9	20·51	20·4
Former Soviet Union	19·17	21·54	21·02	20·85
Latin America & the Caribbean	16·23	17·99	17·75	17·67
Middle East & North Africa	19·52	20·68	20·15	19·98
North America	22·54	23·58	23·26	23·17
South Asia	9·73	12·89	12·64	12·55
Sub-Saharan Africa	11·58	14·89	14·69	14·69

Table A5.5. Nutrient availability under RCP8.5 without CO_2 fertilisation by region. Results in 2010 and 2050, with and without climate change (not including CO_2 fertilisation), are shown by region using Loladze (2014) and Myers et al (2014) datasets.

			2050-nutrient scenarios	
	2010	**2050-climate**	**(Loladze)**	**(Myers et al.)**
Protein consumption (g/person/day)				
Global	95·09	110·27	105·83	107·07
East Asia & Pacific	104·81	132·39	127·58	128·71
Europe	127·99	133·73	128·27	130·27
Former Soviet Union	116·71	129·82	122·31	125·25
Latin America & the Caribbean	98·18	110	107·02	107·97
Middle East & North Africa	113·23	122·95	115·73	118·42
North America	148·95	155·13	150·82	152·27
South Asia	65·87	92·19	87·36	88·5
Sub-Saharan Africa	66·4	82·06	79·8	80·28
Iron consumption (mg/person/day)				
Global	23·78	27·99	27·21	26·9
East Asia & Pacific	27·08	32·21	31·51	31·09
Europe	22·73	24·08	23·23	23·26
Former Soviet Union	24·06	26·86	25·74	25·83
Latin America & the Caribbean	20·86	22·94	22·3	22·12
Middle East & North Africa	27·64	28·66	27·51	27·46
North America	24·52	25·49	24·78	24·75
South Asia	17·31	25·97	25·23	24·83
Sub-Saharan Africa	25·71	32·5	31·68	31·09
Zinc consumption (mg/person/day)				
Global	14·52	16·91	16·5	16·35
East Asia & Pacific	15·65	19·29	18·89	18·7
Europe	19·59	20·69	20·12	19·92
Former Soviet Union	19·17	21·29	20·54	20·26
Latin America & the Caribbean	16·23	17·81	17·46	17·32
Middle East & North Africa	19·52	20·42	19·66	19·37
North America	22·54	23·37	22·91	22·75
South Asia	9·73	12·56	12·2	12·04
Sub-Saharan Africa	11·58	14·59	14·31	14·28

Table A5.6. RNI Ratios for protein, iron, and zinc under RCP8.5 by region and country. Results in 2050, with and without climate change (including CO2 fertilisation), are shown using Loladze (2014) and Myers et al (2014) datasets.

	PROTEIN	2050-nutrient scenarios		IRON	2050-nutrient scenarios		ZINC	2050-nutrient scenarios	
	2050-climate	Loladze	Myers	2050-climate	Loladze	Myers	2050-climate	Loladze	Myers
Global	**3·03**	**2·91**	**2·94**	**1·31**	**1·27**	**1·25**	**1·85**	**1·81**	**1·79**
East Asia & Pacific	**3·65**	**3·52**	**3·55**	**1·92**	**1·88**	**1·85**	**2·81**	**2·75**	**2·73**
Australia	2·91	2·83	2·86	1·95	1·90	1·90	3·46	3·40	3·38
Cambodia	2·39	2·26	2·30	0·42	0·41	0·40	0·68	0·67	0·66
China	4·02	3·88	3·91	2·79	2·73	2·69	3·95	3·86	3·82
Fiji	3·20	3·02	3·09	1·93	1·85	1·86	4·02	3·89	3·83
Indonesia	3·26	3·11	3·16	0·66	0·64	0·63	1·15	1·12	1·11
Japan	3·17	3·09	3·11	1·88	1·83	1·83	2·63	2·58	2·56
Laos	2·80	2·66	2·69	0·50	0·50	0·48	0·76	0·75	0·75
Malaysia	3·54	3·37	3·43	1·42	1·37	1·37	3·08	2·99	2·96
Mongolia	4·23	4·06	4·13	2·73	2·65	2·66	6·08	5·98	5·94
Myanmar	5·88	5·76	5·78	1·64	1·61	1·58	1·17	1·15	1·14
New Zealand	2·74	2·65	2·68	2·27	2·20	2·20	3·43	3·35	3·32
North Korea	1·87	1·78	1·80	0·57	0·56	0·55	1·83	1·79	1·77
Other Indian Ocean	1·72	1·63	1·66	0·60	0·57	0·57	0·78	0·76	0·75
Other Pacific Ocean	1·98	1·89	1·92	1·72	1·67	1·67	2·20	2·14	2·12
Other Southeast Asia	3·40	3·27	3·31	0·70	0·68	0·67	2·95	2·89	2·88
Papua New Guinea	1·62	1·57	1·56	2·42	2·36	2·36	1·80	1·76	1·76
Philippines	2·79	2·65	2·69	1·11	1·09	1·07	1·68	1·64	1·63
Solomon Islands	2·27	2·15	2·17	0·88	0·86	0·85	1·15	1·12	1·11
South Korea	3·21	3·10	3·13	2·21	2·16	2·13	3·31	3·24	3·21
Thailand	2·54	2·43	2·46	1·30	1·28	1·26	1·84	1·80	1·78
Timor L'Este	3·15	3·05	3·08	1·31	1·30	1·27	1·14	1·13	1·12
Vanuatu	2·94	2·80	2·82	2·95	2·87	2·86	1·57	1·52	1·51
Vietnam	3·39	3·25	3·29	1·59	1·57	1·54	1·97	1·93	1·91
Europe	**2·96**	**2·83**	**2·88**	**2·01**	**1·94**	**1·95**	**3·48**	**3·39**	**3·35**
Albania	3·26	3·07	3·14	2·03	1·94	1·95	3·84	3·70	3·65
Austria	3·01	2·89	2·94	2·21	2·13	2·14	3·55	3·46	3·43
Baltic States	2·93	2·81	2·85	1·75	1·70	1·69	3·40	3·29	3·26
Belgium-Luxembourg	2·84	2·72	2·77	1·75	1·69	1·69	3·26	3·17	3·13
Bulgaria	2·74	2·60	2·65	1·56	1·49	1·50	3·41	3·30	3·26
Croatia	2·47	2·35	2·40	1·52	1·46	1·46	2·94	2·85	2·81
Cyprus	2·11	2·05	2·07	1·21	1·18	1·18	2·34	2·28	2·26
Czech Republic	2·82	2·70	2·75	2·31	2·22	2·23	3·47	3·37	3·33
Denmark	3·36	3·23	3·28	1·94	1·87	1·88	3·93	3·83	3·80
Finland	2·86	2·75	2·79	1·50	1·44	1·44	3·26	3·17	3·15
France	3·11	3·00	3·04	2·21	2·14	2·14	3·48	3·40	3·36
Germany	2·59	2·49	2·52	1·94	1·87	1·87	3·18	3·10	3·07
Greece	3·35	3·19	3·24	2·35	2·26	2·26	4·27	4·14	4·09
Hungary	2·87	2·74	2·79	1·78	1·72	1·72	3·21	3·12	3·08
Iceland	2·58	2·49	2·52	1·82	1·76	1·77	3·06	3·00	2·97
Ireland	3·12	3·00	3·04	1·80	1·73	1·74	3·73	3·63	3·60
Italy	3·40	3·24	3·30	2·61	2·50	2·51	4·12	3·99	3·94

Netherlands	2·68	2·59	2·62	1·46	1·42	1·42	3·03	2·96	2·94
Norway	2·75	2·63	2·67	1·62	1·56	1·56	3·33	3·22	3·20
Other Balkans	1·71	1·63	1·66	1·23	1·19	1·18	2·16	2·10	2·07
Poland	3·04	2·89	2·94	2·38	2·29	2·29	3·61	3·48	3·45
Portugal	3·36	3·23	3·27	2·35	2·28	2·27	3·70	3·60	3·56
Romania	3·58	3·40	3·47	2·21	2·13	2·12	4·12	3·99	3·94
Slovakia	2·42	2·30	2·34	1·58	1·51	1·52	2·96	2·86	2·83
Slovenia	2·90	2·80	2·84	1·86	1·80	1·79	3·65	3·56	3·54
Spain	3·12	3·02	3·05	2·20	2·14	2·14	3·42	3·34	3·31
Sweden	2·93	2·83	2·87	1·51	1·46	1·46	3·34	3·26	3·23
Switzerland	2·74	2·63	2·67	1·53	1·47	1·47	3·18	3·09	3·06
UK	2·93	2·82	2·86	1·83	1·77	1·78	3·53	3·44	3·41
Former Soviet Union	**2·99**	**2·81**	**2·88**	**1·89**	**1·81**	**1·82**	**3·32**	**3·20**	**3·16**
Armenia	3·08	2·88	2·95	2·10	2·01	2·01	1·91	1·84	1·81
Azerbaijan	3·18	2·92	3·03	2·30	2·18	2·20	2·08	1·99	1·95
Belarus	2·78	2·67	2·71	2·09	2·03	2·02	3·30	3·20	3·19
Georgia	3·04	2·85	2·92	1·76	1·69	1·69	2·04	1·97	1·94
Kazakhstan	3·75	3·52	3·61	2·30	2·20	2·21	4·51	4·34	4·28
Kyrgyzstan	3·43	3·24	3·31	2·10	2·02	2·02	3·95	3·83	3·78
Moldova	2·77	2·60	2·67	1·87	1·79	1·80	3·44	3·31	3·26
Russia	2·92	2·77	2·83	1·91	1·83	1·84	3·46	3·35	3·30
Tajikistan	2·86	2·62	2·72	0·80	0·76	0·76	1·66	1·58	1·55
Turkmenistan	3·78	3·55	3·65	2·82	2·70	2·71	4·69	4·53	4·47
Ukraine	2·77	2·63	2·68	1·79	1·72	1·73	3·36	3·24	3·21
Uzbekistan	3·12	2·87	2·98	1·97	1·87	1·88	3·72	3·57	3·50
Latin America & the Caribbean	**2·75**	**2·67**	**2·69**	**1·52**	**1·48**	**1·47**	**2·33**	**2·28**	**2·26**
Argentina	3·01	2·89	2·94	2·36	2·27	2·28	6·45	6·29	6·21
Belize	2·42	2·33	2·36	1·57	1·52	1·51	1·26	1·23	1·22
Bolivia	2·81	2·72	2·75	1·29	1·26	1·25	2·86	2·80	2·78
Brazil	3·19	3·11	3·13	2·10	2·04	2·03	3·41	3·35	3·32
Chile	2·87	2·76	2·80	1·62	1·57	1·56	3·60	3·50	3·46
Colombia	2·14	2·08	2·09	1·19	1·17	1·15	2·27	2·23	2·21
Costa Rica	2·38	2·30	2·33	1·34	1·30	1·29	2·48	2·43	2·41
Cuba	2·37	2·27	2·30	1·92	1·87	1·85	1·39	1·36	1·34
Dominican Republic	2·07	2·00	2·02	1·15	1·12	1·11	1·99	1·95	1·94
Ecuador	2·35	2·27	2·29	1·22	1·18	1·18	2·32	2·28	2·25
El Salvador	2·21	2·17	2·18	1·28	1·25	1·23	1·13	1·11	1·10
Guatemala	2·49	2·43	2·45	1·23	1·20	1·18	1·13	1·11	1·10
Guyanas	1·75	1·66	1·69	0·91	0·89	0·88	1·32	1·29	1·27
Haiti	1·63	1·56	1·58	0·45	0·44	0·43	0·82	0·80	0·80
Honduras	2·36	2·31	2·32	1·13	1·10	1·08	1·10	1·08	1·07
Jamaica	2·60	2·50	2·53	1·60	1·56	1·55	2·66	2·60	2·57
Mexico	2·85	2·80	2·81	1·81	1·76	1·74	1·54	1·51	1·51
Nicaragua	2·06	2·00	2·02	0·98	0·95	0·94	1·02	1·00	0·99
Other Caribbean	2·53	2·43	2·47	1·62	1·57	1·57	2·89	2·81	2·78
Panama	2·59	2·50	2·53	1·11	1·08	1·07	2·71	2·66	2·64
Paraguay	2·46	2·41	2·42	1·26	1·23	1·22	2·57	2·53	2·52
Peru	2·45	2·34	2·37	0·66	0·64	0·64	2·45	2·39	2·36
Uruguay	2·84	2·72	2·77	1·95	1·88	1·88	3·69	3·59	3·54
Venezuela	2·13	2·07	2·09	1·06	1·04	1·02	2·34	2·29	2·27

Middle East & North Africa	**3·02**	**2·84**	**2·91**	**1·60**	**1·53**	**1·53**	**1·70**	**1·64**	**1·61**
Algeria	3·10	2·88	2·96	0·92	0·88	0·88	1·83	1·74	1·72
Egypt	3·34	3·16	3·23	2·33	2·24	2·23	1·85	1·79	1·77
Iran	2·95	2·76	2·83	1·98	1·90	1·90	1·65	1·59	1·56
Iraq	1·97	1·79	1·86	0·63	0·60	0·60	1·13	1·07	1·05
Israel	4·37	4·19	4·25	3·34	3·23	3·22	4·55	4·42	4·37
Jordan	2·96	2·80	2·86	1·93	1·86	1·86	1·65	1·59	1·57
Lebanon	3·19	3·04	3·09	2·11	2·04	2·04	1·97	1·91	1·89
Libya	3·04	2·84	2·91	0·96	0·92	0·92	1·92	1·84	1·81
Mauritania	3·26	3·08	3·16	2·19	2·09	2·09	2·73	2·65	2·63
Morocco	3·53	3·31	3·38	2·39	2·30	2·27	2·08	1·98	1·96
Palestine	3·61	3·40	3·48	2·45	2·35	2·36	2·01	1·94	1·92
Rest of Arabia	2·79	2·65	2·70	2·30	2·22	2·22	1·66	1·61	1·59
Saudi Arabia	2·43	2·31	2·36	1·69	1·63	1·63	1·37	1·33	1·32
Syria	3·32	3·12	3·19	2·35	2·25	2·25	1·87	1·80	1·77
Tunisia	3·63	3·40	3·48	2·64	2·53	2·53	2·20	2·10	2·07
Turkey	3·62	3·43	3·50	2·34	2·24	2·25	1·94	1·87	1·84
Yemen	2·17	2·03	2·09	0·54	0·52	0·52	1·02	0·98	0·97
North America	**3·16**	**3·07**	**3·10**	**2·31**	**2·24**	**2·24**	**3·94**	**3·86**	**3·83**
Canada	3·01	2·90	2·94	2·40	2·33	2·32	3·68	3·59	3·55
Greenland	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
USA	3·18	3·09	3·12	2·30	2·23	2·23	3·97	3·89	3·86
South Asia	**3·02**	**2·86**	**2·90**	**0·79**	**0·77**	**0·76**	**1·03**	**1·00**	**0·99**
Afghanistan	2·88	2·66	2·75	0·84	0·80	0·80	1·24	1·20	1·18
Bangladesh	2·81	2·62	2·68	0·52	0·51	0·50	0·72	0·70	0·69
Bhutan	2·83	2·76	2·77	0·85	0·84	0·82	1·47	1·44	1·44
India	3·12	2·96	2·99	0·84	0·82	0·80	1·02	0·99	0·97
Nepal	3·39	3·23	3·28	0·99	0·96	0·95	1·52	1·49	1·47
Pakistan	2·66	2·50	2·57	0·76	0·72	0·73	1·20	1·16	1·14
Sri Lanka	2·84	2·69	2·74	0·81	0·78	0·78	1·55	1·49	1·48
Sub-Saharan Africa	**2·63**	**2·55**	**2·57**	**1·15**	**1·12**	**1·10**	**1·22**	**1·19**	**1·19**
Angola	2·34	2·25	2·28	1·85	1·81	1·78	0·96	0·94	0·93
Benin	2·58	2·51	2·53	0·81	0·80	0·78	1·15	1·14	1·13
Botswana	2·16	2·10	2·12	1·67	1·62	1·61	1·00	0·98	0·98
Burkina Faso	3·69	3·66	3·66	1·32	1·30	1·26	1·71	1·69	1·69
Burundi	2·62	2·56	2·56	0·85	0·83	0·82	1·04	1·01	1·01
Cameroon	2·27	2·20	2·21	0·82	0·80	0·79	1·11	1·09	1·09
Central African Rep.	2·85	2·79	2·80	1·68	1·65	1·63	1·32	1·31	1·31
Chad	3·09	3·03	3·05	1·63	1·58	1·55	1·42	1·39	1·40
Congo	2·44	2·32	2·36	1·43	1·38	1·39	0·91	0·88	0·88
Djibouti	2·43	2·30	2·35	0·64	0·61	0·61	2·10	2·05	2·02
DRC	1·11	1·09	1·09	0·65	0·64	0·63	0·42	0·41	0·41
Equatorial Guinea	1·10	1·07	1·07	1·01	1·00	1·00	0·55	0·55	0·55
Eritrea	2·25	2·14	2·18	1·01	0·97	0·96	0·89	0·86	0·85
Ethiopia	3·21	3·06	3·09	2·56	2·45	2·41	1·49	1·41	1·43
Gabon	2·58	2·47	2·50	2·30	2·23	2·22	1·03	1·01	1·00
Gambia	2·33	2·26	2·28	0·89	0·87	0·85	1·03	1·02	1·01
Ghana	2·34	2·26	2·27	0·83	0·81	0·80	1·05	1·03	1·03
Guinea	2·71	2·55	2·58	1·51	1·45	1·44	1·24	1·21	1·21
Guinea-Bissau	2·10	2·01	2·04	0·83	0·81	0·80	0·96	0·95	0·95
Ivory Coast	2·03	1·93	1·95	0·81	0·80	0·79	0·97	0·96	0·96

Kenya	2·50	2·44	2·46	0·72	0·70	0·69	1·07	1·05	1·04
Lesotho	2·54	2·46	2·49	2·30	2·23	2·19	1·23	1·20	1·20
Liberia	2·12	2·01	2·04	0·62	0·60	0·60	0·82	0·80	0·79
Madagascar	2·27	2·15	2·18	0·52	0·51	0·50	0·85	0·84	0·83
Malawi	2·44	2·40	2·41	0·75	0·73	0·72	0·96	0·95	0·95
Mali	2·82	2·76	2·77	2·10	2·07	2·00	1·32	1·31	1·30
Mozambique	2·30	2·24	2·26	0·74	0·72	0·71	0·95	0·94	0·93
Namibia	3·08	2·98	3·01	2·39	2·33	2·31	1·35	1·33	1·32
Niger	4·20	4·17	4·17	1·65	1·63	1·57	2·04	2·02	2·01
Nigeria	2·85	2·77	2·79	1·05	1·03	1·01	1·40	1·38	1·37
Other Atlantic	2·17	2·09	2·11	1·60	1·55	1·54	0·95	0·93	0·92
Rwanda	2·86	2·79	2·79	1·03	1·00	1·00	1·19	1·17	1·16
Senegal	2·40	2·30	2·34	0·75	0·74	0·72	1·10	1·08	1·07
Sierra Leon	2·17	2·07	2·10	0·75	0·73	0·73	0·74	0·73	0·72
Somalia	2·96	2·94	2·94	0·36	0·36	0·35	1·15	1·14	1·14
South Africa	2·87	2·77	2·81	1·57	1·52	1·50	1·36	1·34	1·33
Sudan	2·75	2·70	2·71	0·83	0·81	0·79	2·59	2·56	2·55
Swaziland	2·57	2·49	2·52	0·80	0·78	0·77	1·19	1·17	1·17
Tanzania	2·77	2·70	2·71	0·83	0·80	0·80	1·08	1·06	1·06
Togo	2·42	2·36	2·37	0·75	0·74	0·72	1·09	1·08	1·07
Uganda	2·76	2·70	2·70	0·85	0·83	0·82	1·05	1·03	1·03
Zambia	2·66	2·60	2·62	0·83	0·81	0·79	1·03	1·01	1·01
Zimbabwe	2·76	2·71	2·73	0·75	0·74	0·72	1·19	1·18	1·17

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